Report Information from Dialog DataStar



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Chemical routes to improved mechanical properties of PECVD low k thin films.

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Bilodeau, S.M., Borovik, A.S., Ebbing, A.A., Vestyck, D.J., Xu, C., Roeder, J.F., Baum, T.H., ATMI Inc., Danbury, CT, USA.

Abstract

Increasing the elastic modulus and hardness of low k films is one of the key challenges towards integration of these materials into future integrated circuits. Several approaches are explored for increasing the hardness of carbon doped oxide (CDO) dielectrics. Several low k precursors and their mixtures specifically chosen to enhance the hardness (H) and modulus (E) of CDO films through chemically induced cross–linking. Composition and FTIR measurements suggest the presence of C–C and C–Si cross–linking with concurrent observation of improved film hardness and modulus at relatively low deposition temperatures. Films deposited at 373°C using diethoxy–methyl–oxiranyl have a hardness and modulus of 2.5 GPa and 18.1 GPa, respectively. Films deposited at 180°C using tetramethylcyclotetrasiloxane (TMCTS) and 25% hardener have hardness and modulus of 1.5 GPa and 9.4 GPa, respectively. These film properties are significantly higher than those observed for TMCTS alone under similar deposition conditions. Based on these results a low temperature process with 25% hardener and 75% TMCTS combined with a porogen was used to produce a porous film with a k<2.5 and a hardness of 0.72 GPa.

Descriptors

DIELECTRIC-THIN-FILMS; ELASTIC-MODULI; FOURIER-TRANSFORM-SPECTRA; HARDNESS; INFRARED-SPECTRA; ORGANIC-COMPOUNDS; PERMITTIVITY; PLASMA-CVD; POROUS-MATERIALS.

Classification codes

A6860 Physical-properties-of-thin-films-nonelectronic*;

A8140J Elasticity-and-anelasticity;

A6220D Elasticity-elastic-constants;

A8140N Fatigue-embrittlement-and-fracture;

A6220M Fatigue-brittleness-fracture-and-cracks;

A7755 Dielectric-thin-films;

A7720 Dielectric-permittivity;

A7830G Infrared-and-Raman-spectra-in-inorganic-crystals;

A7865P Optical-properties-of-other-inorganic-semiconductors-and-

insulators-thin-films-low-dimensional-structures;

A6825 Mechanical-and-acoustical-properties-of-solid-surfaces-and-

A8115H Chemical-vapour-deposition;

A6855 Thin-film-growth-structure-and-epitaxy;

A5275R Plasma-applications-in-manufacturing-and-materials-processing;

B0520F Chemical-vapour-deposition*.

Keywords

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chemical-method; elastic-modulus; film-hardness; PECVD-low-k-thin-films; mechanical-properties; integrated-circuits; carbon-doped-oxide-dielectrics; low-k-precursors; CDO-films; chemically-induced-cross-linking; composition-measurement; FTIR-measurement; C-C-cross-linking; C-Si-cross-linking; diethoxy-methyl-oxiranyl; tetramethylcyclotetrasiloxane; porous-film; porogen; film-properties; deposition-temperatures; 373-degC; 180-degC.

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X Experimental.

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